while in contrast the stronger effect weakens the effect it accompanies, here the reverse holds true. With these are connected two other types of illusions, the one referring to the change of form of the contour of an interrupted figure, as when a portion of the circumference of a circle is omitted; the other to the contrast induced by placing the smaller side of one of two equal figures next to the larger side of the other figure, and thus causing the first to seem smaller, etc. These illusions are all clearly marked, have a wide field of application, and promise to repay further study. J. J.

Das Netzhautbild des Insectenauges. Prof. SIGMUND EXNER. Repertorium der Physik, Bd. XXV, H. 9 und 10, 1889; also Sitz.-Ber. der Wiener Akad. (3 Abth.) Bd. 98 (1889).

In this paper, which in some sense corrects and completes an earlier one on a similar subject, Prof. Exner seems to have definitely settled the question as to whether insects with compound eyes see by means of a single erect image, (Johannes Müller's view), or by means of a multitude of little inverted images, (as held by several later observers), and to have settled it in favor of the earlier view, at least with modifications. By taking the eye of the male firefly (*Lampyris splendidula*), (the same might be done with the American *Elater noctilucus*), replacing the softer parts with diluted glycerine, and mounting it under the microscope (power of 60-100) in such a manner that the convex surface was free to the air as in life and the focal plane of the microscope lay in the place once occupied by the retina, he was able to observe the image directly, and by focussing up and down to study its nature and formation. The dioptric unit of the compound eye in this insect consists of a crystal cone (*Krystallkegel*), the lower end of which is rounded into a lens-like point, and of the attached corneal facet, also lens-shaped. This crystal cone, assisted somewhat by the lens-forms at its ends, but depending in large measure on its own peculiar refractive powers, behaves like a minute astronomical telescope and projects an erect image of the portion of space to which it is directed on the retinal elements lying below it. The neighboring cones also project similar images, each differing slightly because of the different directions of the cones. The points of these images that represent the same objective points in space coincide, and thus form a "summation image," which was that observed by Exner. In the eye of *Lampyris* as many as thirty cones contribute to the "summation image" of a small light object. The peculiar refractive powers of the cones rests in the increase of the refractive index in successive strata from the convex surface toward the axis. To account for the presence of large quantities of pigment in the space between the crystal cones and the retina in some insects and its absence in others (*e. g.* these fireflys) the author offers this hypothesis, which in a later paper (*Sitz.-Ber. der Wiener Akad.* Bd. 98, (3 Abth.,) v. 21 März, 1889.) he has substantiated by observation, namely that when the eye is exposed to light the pigment spreads backward from the region of the cones into the otherwise free space. The effect of this would be to cut off as it advanced more and more of the single images going to form the "summation image," proportionately reducing its intensity; it would thus serve the same function as the iris in the eye of higher forms. The author by no means believes that the eye of *Lampyris* is typical of all composite eyes, though the understanding of it is an advance; indeed he devotes a section to the consideration of other forms in which the structure is different. For these details, however, and for very much information not easily abstracted, or not of immediate interest here, *e. g.*, the other optical images to be observed in addition to that mentioned above, the physico-mathematical consideration of the crystal cones, the measurement of the eye, the

developmental relations of the simple vertebrate eye and the compound eye, etc., etc., the reader is referred to the full treatment and the cuts of the original. E. C. S.

Psychophysische Untersuchungen. Dr. F. C. MÜLLER-LYER. DuBois-Reymond's Archiv. Supplement Band. 1889. pp. 91–141.

This very extensive research is so intimately connected with the many explanatory tables and illustrations, that a resumé of its contents must be confined to a statement of the most general points; special students of psychophysics must go to the article itself for the detailed numerical results and their justification. The article begins by maintaining that it is wrong to speak of *the* psychophysic law, for there may be any number of such laws; the problem is to determine all the conditions that affect sensibility to differences of stimuli, and the intensity is but one of such conditions. There will be here considered the relation of the intensity and the extension of optical stimuli to the sensibility. The author had shown that Weber's law does not hold for sensations of brightness (method of detecting the difference between two differently illuminated discs), but as the stimuli increase, the sensibility increases, though at a constantly decreasing rate. This was tested separately for each eye, with a light disc upon a darker ground or vice versa, for a great range of intensities, etc. This may also be expressed by regarding the effect of the application of the stimulus to be the lowering of the irritability, but not as rapidly as the stimulus increases. It is concluded that for visual sensations, as the stimulus doubles its value, the irritability decreases by one-third its value. Some of these points were specially tested for peripheral regions of the eye, and it was found that such portions are in general more sensitive to the vision of small dots than the fovea, and also that Weber's law seems to hold better for the peripheral than for the foveal portions. Had the sensibility been independent of the intensity of the stimulus, the determination of the relation of sensibility to the extension of the stimulus would be easy; but as it is, we are dealing with two variables at a time, and have the complex problem of determining how the sensibility changes for each intensity when the extension remains constant, and how it changes for each extension when the intensity remains constant. This the author does for visual sensations, expressing the result by a surface in the three dimensions of space. For changes in extension, the general result is that as the surface upon which the judgment of difference of illumination is founded is increased, the sensibility increases, at first relatively rapidly, and then more and more slowly. These relations are subjected to a minute experimentation, the result of which is a series of tables expressing the influence of the changes in any one of the factors of the stimulus upon the rest. The main point is the treatment of the sensibility, not as dependent upon a single variable, but upon several. The article certainly merits detailed study, but the question arises whether these exact and many-sided calculations are warranted by the accuracy of the method, and whether we should not demand a corroboration of these results by other methods before drawing the sweeping generalizations here propounded. J. J.

Neue Grundlegung der Psychophysik. HUGO MÜNSTERBERG. Beiträge zur experimentellen Psychologie. Heft, 3. Freiburg, 1890. pp. 122.

It is impossible to notice this original and painstaking contribution to Psycophysics without renewing the protest against the undue length to which all the studies of this series have been drawn. It is not sufficient that the spirit of science should enter into the methods of the new Psychology; it must also enter into its exposition, and we feel assured that the author is very considerably diminishing the influence of his